6,5,1 (341K) I1-031

I. Executive Summary

Assessment of Contaminant Trophic Transfer from Asian Clam (*Potamocorbula amurensis*) to White Strugeon (*Acipenser transmontanus*): A Biomarker Monitoring Approach

Mark S. Okihiro DVM Ph.D., Swee J. Teh Ph.D., and David E. Hinton Ph.D.
Department of Anatomy, Physiology, and Cell Biology, University of California, Davis

Project Description: The San Francisco Estuary has recently been recognized as the most invaded aquatic ecosystem in North America, with 212 introduced species identified to date (Cohen and Carlton, 1995). Asian clam (*Potamocorbula amurensis*) were first collected in the Estuary in 1986 and have since proliferated reaching densities greater than 20,000/m^2 in some regions (Carlton *et al.*, 1990). Since the appearance of the Asian clam, the benthic community has experienced drastic species composition changes, the summer diatom bloom has disappeared, and some surface water zooplankton populations have declined (Nichols *et al.*, 1990; Alpine and Cloern, 1992; Kimmerer *et al.*, 1994; Cohen and Carlton, 1995). Asian clam are highly efficient filter feeders (Werner and Hollibaugh, 1993) and in some areas, are documented to accumulate metals to a greater degree than native clams (Brown and Luoma, 1995). In addition, the Asian clam is a readily available food source to benthic predators and, in limited sampling by our laboratory and the Department of Water Resources, constituted the majority of the gastrointestinal contents of white sturgeon (*Acipenser transmontanus*). Considering the Asian clam is such an efficient accumulator of metals and white sturgeon prey upon them, studying the trophic interactions between these two species may provide a direct and remarkable example of a negative interaction between an introduced species and a higher order predator.

Standard methods for assessing trophic transfer of contaminants relies upon determining the tissue body burdens (Taberski, 1995). Such data are useful for establishing maximum levels of fish consumption for human health purposes, yet yield no information on associated deleterious effect to fish. Alternatives include documenting the occurrence of histologic lesions (in liver and other organs), which have been observed in marine fish feeding on contaminant-laden benthic invertebrates (Myers *et al.*, 1994). Monitoring of other markers, such as induction of metal binding proteins and inhibition of proteins involved in essential nervous system function, can provide definitive evidence of exposure to a narrow class of compounds. The principal objective of the proposed research is to identify and develop a suite of biochemical and histopathological indicators of dietary contaminant exposure in white sturgeon fed contaminant-spiked diets and Asian clams and to validate findings with field collected fish.

Approach/Tasks/Schedule: Specific aims are: 1) to determine the effect contaminant type, concentration, and duration of exposure of prepared diets with set quantities of added contaminants on biomarker expression in white sturgeon; 2) to correlate biomarker expression with tissue contaminant levels; and (3) to assess xenobiotic trophic transfer from Asian clams to white sturgeon under laboratory and field conditions. Laboratory exposures will use representatives of two major contaminant groups found in the Estuary: metals (cadmium and selenium) and organophosphate pesticides (diazinon). Task I (year 1) will focus on exposure of white sturgeon to single compounds (to simulate trophic transfer) in established diets for 12 wks. Biomarkers assessed will include metallothionein, P450 enzymes, stress proteins, acetylcholinesterase (AChE) inhibition, and histopathology. Tissue body burdens will be determined and correlated with biomarker expression. Task II (year 2) will focus on feeding clams with high metal body

burdens to sturgeon and documenting biomarker expression and body burden. Task III (year 3) will involve validation of biomarkers identified in Tasks I and II in wild sturgeon.

Justification for Project and Funding by CALFED: Increased trophic transfer of contaminants from an introduced species to a native fish has implications for both human health and the health of the fish population. Current methods for assessing human health impacts include identifying tissue body burdens and posting warnings regarding the maximum consumption of contaminated fish (Taberski, 1995), yet such studies do not investigate the impact of these body burdens upon the fish . Therefore, funding of this study by CALFED is justified for several reasons. First, this study will initiate a unique monitoring approach for mobilization of contaminants via trophic transfer by linking tissue body burdens (human health) with biomarker expression (fish health). We will work closely with the Department of Fish and Game to supplement their data for sturgeon contaminant accumulation and provide a clearer understanding of how tissue accumulation is associated with biological effect in the fish. Second, although white sturgeon were not listed as a species of concern in the CALFED RFP, studies of trophic transfer from the Asian clam to white sturgeon are warranted for several reasons. White sturgeon can serve as a surrogate for trophic transfer to green sturgeon because: (1) both species inhabit the same habitat and consume similar prey items, (2) there is no cultured source of green sturgeon for laboratory studies, (3) they are more abundant for field surveys, and (4) their collection only requires a scientific permit. Third, results from this proposal would establish the ecological significance of cadmium, selenium, and diazinon to an important fishery which has been in decline for nearly a decade. Finally, the Asian clam has had a serious impact on the ecology of San Francisco Bay. All indications are that this introduced species mobilizes an increased contaminant load to organisms which prey upon it. However, there have been no studies to date to investigate this problem.

Budget Costs and Third Party Impacts: The total budget costs for this proposal is $341,857. There are no direct third party impacts associated with the proposed research. However, a comprehensive identification of tissue body burdens for sturgeon in northern San Francisco Bay (Task III) will provide the Department of Fish and Game with data for modifying maximum human consumption levels of sturgeon.

Applicant Qualifications: Dr. Okihiro, a veterinarian with a Ph.D. in comparative pathology (mammalian and aquatic animals), has extensive training and field research experience in conducting pathological and toxicological investigations with fishes. Dr. Teh has ten years of research experience in environmental toxicology and pathology. He is currently managing an internationally known Aquatic Toxicology Laboratory at U.C. Davis. Dr. Hinton has 28 years of continuous experience with pathobiology of fishes and emphasis on aquatic toxicology.

Monitoring and Data Evaluation: Task III of this proposal will focus on monitoring biomarker expression and tissue body burdens in sturgeon collected from northern San Francisco Bay. Results will be provided to staff from the Department of Fish and Game Sturgeon Program, providing additional data for use in establishing recommended fish consumption limits and new data on fish health. To date, the CDFG Strugeon Program does not include a component investigating contaminant impacts on this species. Data will be evaluated by correlating biomarker occurrence with tissue body burdens, exposure concentrations, and duration of exposure.

Local Support/Coordination with other Programs/Compatibility with CALFED Objectives: This proposal will partially rely on collaboration with the United States Geological Survey's for collection of Asian clams from sites in northern San Francisco Bay with well defined contaminant analyses. As stated above, this proposal will also supplement the CDFG Sturgeon Program.

I-007540